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AUTHOR Bowyer, Jane
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ABSTRACT

Problems related to small numbers of women in science-related occupations are reviewed. The results indicate inadequate science background at the elementary and secondary levels as one possible reason. The study cites nine National Science Foundation research projects specifically related to women in science and suggests that science curricula, textbooks, teacher effects, and counseling could be used to encourage females to enter science-related fields. It speculates that disproportionate amounts of academic support are necessary to overcome cultural values and educational experiences which mediate against females' achievement in science. (Author/DS)

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SCIENCE EDUCATION FOR THE EIGHTIES: NEW TARGET POPULATIONS*

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Jane Bowyer

Mills College

Oakland, California

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I would like to preface my remarks this morning concerning "Women and Science Education" by referring to two Presidential statements that were made one year apart: the first in February, 1980; the second in March, 1981. The importance of these two realities must form the backdrop against which we view all our remarks.

On February 18, 1980 President Carter requested the Secretary of Education and the Director of the National Science Foundation to examine the adequacy of science and engineering education in terms of the Nation's long-term needs. Eight months later, in October, 1980, their report was published. Headlines from the "Chronicle of Higher Education's" (1981a) front page story summarize the essence of the report: "Crisis in Science Education". Briefly, the Presidential report describes a declining emphasis in science and math in our school systems. This is in marked contrast to other industrialized countries such as Japan, Germany and the Soviet Union. Specifically, only about one-third of our nation's high schools require more than one year of math or science for graduation. Colleges and universities have reduced the number of math and science subjects they require for adminssion. Two serious problems are precipitated by this state of affairs. First, students who take no more math and science beyond their tenth year in school have effectively eliminated, by age sixteen, the possibility of science or engineering as a career.

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This comes at a time when the Bureau of Labor Statistics is predicting a 40% growth rate in job opportunities in science and engineering between 1980 and 1990! Second, a decline in emphasis in secondary science and math contributes alarmingly to the scientific illiteracy of our citizenry. This is compounded further when coupled with data from the Stake and Easley (1978) N.S.F. case studies that estimate fewer than half of the children in the United States experience even one year in elementary school science as an integral part of the curriculum. We are faced with the frightening prospect of a society on the one hand becoming ever more dependent on science and technology and a population on the other that is growing ever more ignorant in its understanding of even the basic rudiments of scientific thinking!

The second Presidential proclaimation occurred on March 10th this year. President Regan dispatched to Congress his 1981 budget proposal. Again, newspaper headlines summarize the essence of that part of the budget concerning this morning's topic: from "Science" magazine (1981) "Science Education Axed': and from "The Chronicle of Higher Education", 'Science Education Cuts: It's Hard to be Optimistic' (1981b). Under President Regan's plan, N.S.F.'s science-education projects will be virtually eliminated within one year. The sixty-four million dollar education budget would be reduced 86% leaving only that portion dealing with a handful of fellowships awarded in previous years. Cut would be support for (1) programs to train secondary school science teachers, (2) monies to upgrade science equipment and curriculum development, (3) science education research, and (4) public understanding of science programs.

In summary, as we enter the 1980's we face serious problems in science education and it appears that they must be solved without Federal support.

WOMEN AND SCIENCE

Since men and women today have equal access to schooling, it is easy to think that the two sexes enjoy identical educational experiences. This, however, is not the case. In a random sampling of freshmen admitted to the University of California's Berkeley campus, sociologist Lucy Sells (1975) found that 51% of the boys had taken four full years of mathematics in high school (including the trig-solid geometry sequence) compared with 8% of the girls. The four year high school math sequence is required for admission to Math 1A at Berkeley, which in turn is required for majoring in every field at the University except for the traditionally female fields such a humanities, social sciences, and education.

The career filtering that occurs when students don't take high school math is especially critical for women. For all practical purposes access to science-related jobs for most girls is eliminated before they begin college. As Alice Rossi (1965) notes, whether through inadequate counseling or personal choice, women simply are not taking enough of the optional mathematics courses offered in high school to prepare them to enter programs in science. Although women have been entering the labor force in this country in record numbers during the past twenty-five years, a 100% increase during that time according to the U.S. Department of Labor, the number of women choosing scientifically related careers has not increased but has declined slightly (Astin, 1978).

In the last five years the United States Government made a substantial effort to increase women's access to scientific careers.

It is too costly to have 50% of our population, because of inadequate educational preparation, unable to contribute fully to scientific and technological achievements in our society. Literally hundreds of "out of school" projects to encourage women in science, engineering and math have been conducted. For example, the National Science Foundation funded "visiting scientists" programs for high schools and "career information" workshops for college level women. Unfortunately efforts aimed at high school and college students are often too late. Attention must be aimed at elementary school students.

Early research indicates that curricula that use experimental activities and encourage individual experimentation tend to facilitate women's participation and performance in science. One such study involving 500 sixth grade children evaluated the Science Curriculum Improvement Study (SCIS) curriculum (Bowyer and Linn, 1978). Its unique feature was that students had no textbook but rather learned about science concepts from their own experiments. It was found that children who had used this curriculum from the first grade through sixth grade were better able to understand and think logically about science problems. The unexpected finding was that girls did as well as the boys. This finding is spoken of as a surprise because reports from the National Assessment of Educational Progress (1978) in assessing school children's knowledge during the last decade have repeatedly shown that girls all over the United States are less knowledgeable than boys in science.

It is of interest to know whether girls' attitudes toward science might also be modified as a result of specific curriculum experiences in school since studies show that girls of all ages

are consistently less positive than boys in their attitudes and feelings toward science. One study (Lowery, Bowyer, Padilla, 1980) indicates that girls' attitudes regarding science and the scientist can, in fact, be positively affected by special curriculum experiences. Interestingly, the boys' attitudes in the study were also positively changed, the net result being that the difference between the girls and boys was identical to the attitude difference between the control group girls' and boys'. Innovative curriculum might be able to modify attitudes but male-female differences still persist. Appropriate curriculum experiences appear to be necessary but insufficient for changing deeply held societal values toward science and women.

Certain teacher behaviors appear to have positive effects on female participation in science at both the elementary and secondary levels (Lindsay, 1973). Regardless of whether a teacher is male or female if the following cluster of behaviors exist, girls participate more fully and positively in school science: (1) use of responsive, flexible teaching style; (2) exhibition of a positive attitude toward science; (3) demonstration of an interest in science; and (4) display a belief in the ability of all students to learn from their own science experiments.

In addition to particular curriculum and teacher effects, another approach that has been successful for increasing girls' performance in science is relying on older girls to counsel, encourage and tutor younger girls (Casserly, 1978). Modifying sexually stereotypic textbook materials is also extremely useful in counteracting prevailing popular public attitudes toward science and the scientist.

In 1980 the National Science Foundation funded nine research projects specifically dealing with women and science. The total amount of money being expended for these projects is just over $1,000,000.00. A brief summary of the projects follows.

(1) A study proposing to develop a longitudinal evaluation use with the "out of school" projects referred to earlier in this presentation.

(2,3) Two projects are aimed at curriculum development for the college or post-college student. One is developing a visual geometry course for women in order to develop skills in interpreting computer graphics. Later students must transform the visuals into symbolic form. The other project in this class is the development of a curriculum to retrain post-bacculaurete women for careers in engineer.

(4) A study attempting to identify teacher behaviors at the junior high level that affect student achievement in science.

(5) UCLA project developing materials for use with college female science majors and junior high school girls in role-model workshops.

(6) A study in the area of career counseling to new norms for vocational interest inventories. Unfortunately since women were not included as a substantial factor in the development of the scales, the norms are biased and may be influencing effective career counseling at the high school level.

(7,8,9) Surveys to determine critical factors that improve the likelihood of women selecting science related careers. One project is completing a literature search and analysis of high school women and science; the second is resurveying a substantial subset of the 1969-70 National College Freshmen Sample to identify primary influences on women who did and did not select science careers; the third is studying the course-taking patterns of women majoring in college science.

In conclusion, it is worth remembering that schools are socializing agencies that have the potential for modifying students' attitudes and knowledge when it is sufficiently important to do so. However, schools cannot accomplish important changes such as equalizing opportunity unless social reforms accompany the educational effort. When cultural values mediate against female achievement as they do in science, disporportionate amounts of academic support will be necessary to overcome their effects.

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